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FINAL REPORT

LOADING STUDY

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F I N A L R E P O R T

LOADING STUDY

Introduction

This task has been concerned with the redesign of a system for the inflation and the loading of leaflets in high altitude balloons under adverse weather conditions. The prime objectives of this project have been:

1. To design and fabricate a weather shield of light collapsible construction with sufficient strength to withstand winds up to 25 miles per hour, capable of being erected and dismantled in a maximum time of three minutes by four men or less. The shield was also to be resistant to salt spray corrosion and conductive to static electricity. Further, to construct three prototype weather shields of the accepted design.
2. To provide a means for the rapid inflation of the balloon within the weather shield and a means for metering the gas to obtain the free lift needed for the balloon to reach the required altitude; and to provide a pilot lot of the accessories required.
3. To provide a method for carrying the leaflets in the balloon system, which would allow for rapid loading of the leaflets to the balloon within the weather shield and insure dependable dispersing of the leaflets over the target area. A pilot lot of the carriers was also to be provided.

1. Weather Shield

Many designs were conceived for the construction of the weather shield. Four of these considered worthy of investigation were:

a. Folding rectangular box

b. Telescoping cylinder sectors

c. Plastic hemispheres

d. Accordian folding fabric covered frame

Models were made of these designs to study their advantages and disadvantages. The fabric covered frame, which was made in a half-size scale model appeared most favorable and won acceptance by the project officer.

Full size parts were made and studied for the development of the final shield design. This consists of: a folding base; an accordian folding, fabric covered frame; and a removable, fabric covered top. The base is octagonal, 5'9" between opposite edges, and is hinged on a bisecting line so that it will fold in half for easy storage and handling. It is designed to be mounted on a stand above floor level. Therefore, in order to permit an operator to stand within the shield a 2' x 2' section is cut out of the octagon at one edge. It is made of plywood covered with 0.032" aluminum sheet and edged with standard 13/16" stainless steel channel molding.

The accordian folding, fabric covered frame forms seven sides of an octagonal cylinder when mounted on the base. Each side, or panel, is a rectangular frame (approximately 2'4" by 6') made of welded electrical conduit with corner braces for rigidity. The panels are hinged together so that they will fold flat accordian style when removed from the base. When mounted on the base, five panels are securely fastened to the base but the two panels adjacent to the open side may be latched in place or allowed to swing open as doors.

The removable top consists of two curved rods and the fabric cover. The ends of the rods are inserted in the open ends of the vertical conduit of the frame. By spanning the top of the frame these rods give greater rigidity to the frame assembly and support the roof fabric.

The fabric used as a cover for the shield needed to be lightweight, flexible, abrasive resistant, high in tensile strength and not susceptible to the accumulation of statical electricity. Neoprene coated nylon fabric was obtained with a conductive coating which brought its surface resistivity down to 5×10^8 ohms per square.

The weather shield fully assembled stands approximately 7 feet high on the 5'9" octagonal base and weighs about 180 pounds. When disassembled and folded, the sides and top require a storage space of 1'0" x 2'4" x 6'0", and the base requires a space about 5'10" x 2'11" x 0'6".

2. Inflation Studies

To improve the speed with which the J-100 balloons could be loaded with leaflets, inflated, and launched, a study of rapid inflation techniques was undertaken. At high rates of inflation, premature bursts were encountered with alarming regularity. The internal load of leaflets was picked up by the high velocity jet of gas entering the neck of the balloon and the swirling leaflets nicked the inside surface of the balloon and occasionally punctured it. By comparing premature burst frequencies with and without internal loads, the leaflets were found definitely to contribute to this difficulty. Other effects of the high rate of inflation were distortion of the balloon during inflation (which could also contribute to a lesser extent to premature bursts) and mutilation of the leaflets.

The inflation nozzle was increased in inside diameter to reduce the velocity of the gas jet entering the balloon and thereby reduce distortion. Abnormal strains between the neck and the filling nozzle caused leaks at high inflation rates. During this study a plastic neck closure was conceived which would replace the awkward "tie-off" operation, relieve the nozzle insertion and inflation difficulties, and provide means of attaching an external payload carrier. A pilot lot of 25,000 plastic closures was made with production tooling.

3. External Carriers

As a result of the discoveries made in above studies, it was decided to devise a system for carrying the payload outside the balloon. Several kinds of external carriers were made and tested. Some did not disperse the payload when the balloons were burst at altitudes of 200 - 300 ft. It was contemplated that balloon, carrier, and payload might fall to the ground together even from 30,000 ft. A carrier with an added air scoop, however, dispersed the leaflets beginning with the first few feet of falling. A pilot lot of 60,000 air-scoop carriers was obtained.

Consideration was given to methods of metering the gas to obtain the desired free lift. The parameters chosen for gaging free lift included pressure, gas quantity, balloon diameter, and automatic weighing. The first of these, pressure, was not considered feasible since the pressure decreases as the balloon is inflated. However, pressure vs. lift vs. diameter was determined. The pressure decreases to a minimum at about the point of proper lift and then increases until at burst it is about the same as the starting pressure. Since the slope of the curve pressure vs. lift is zero at the desired lift, this parameter cannot be used for gaging lift. Diameter proved difficult to measure and some balloons were distorted to uneven skin thickness. Gas quantity obtained by integrated flow metering appeared feasible but not within the time and money limitations of this task. Automatic weighing was discarded for the same reason. The weigh-off system was improved however by using a free lift weight made of chain links instead of a single weight. The operator may now see how rapidly the proper lift is approached as successive links are lifted.